LCA Methodology

Application Typologies for Life Cycle Assessment

A Review

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Abstract

Different lists of application areas for life cycle assessment are reviewed together with some suggestions for a typology of these application areas. It is concluded that the scope of a life cycle assessment is determined by the area of validity of the decision with respect to time, space, and interest groups affected. On this basis, six application areas are distinguished. It is further concluded that the application area has limited influence on the inventory analysis and impact assessment phases, although these may be influenced significantly by the decision-maker and the complexity of the trade-offs between the involved environmental impacts. The reporting format for a life cycle assessment depends on the socio-economic importance of the decision, the intended audience, and the time available for decision making.

Keywords: Application areas, LCA; application typologies, LCA; decision making, LCA; Life Cycle Assessment; LCA; methodological requirements

1 Review

Life cycle assessments have many applications (→ *Table 1*), and it is generally recognised that the application area determines the specific methodology to be applied in a life cycle study, even to the extent that life cycle assessments made for one application cannot be used for another application. A typology of application areas may therefore increase our understanding of the specific relations between the methodological requirements and the application areas. The following review covers suggestions on such typologies and their determining parameters offered by different authors.

A distinction, which was identified very early (see e.g. FAVA et al. 1991) was *internal versus external/public applications*. The background and education of the intended audience and the time available for decision making may be different for the different application areas listed in **Table 1** and this may influence the reporting requirements. However, while the publication strategy may be implicit in the objective of the study, there is no apparent link between the intention to publish and the methodology of the study as such.

In my Ph.D. thesis (WEIDEMA 1993), I suggest a typology (→ *Table 2*) based on:

- *enterprise specific versus generic applications*,
- *operational, tactical or strategic applications*, which are defined theoretically, see note[1]
- *application for information versus decisions on change*, thus giving a matrix with 12 application areas, implicitly or explicitly covering all the areas listed in **Table 1**.

[1] The operational level is characterised by being non-comparative and by the result being used directly on the product itself, the typical example being product declaration. The tactical level is characterised by improvements being evaluated by comparison between products and by the result being used to influence the surroundings of the product: producers, suppliers, employees and customers, the typical example being eco-labelling criteria. The strategic level is characterised by improvements being evaluated in relation to an environmental target and by the result being used to place the product in a larger context.

Table 1: Two lists of application areas

ISO 1996	LINDFORS et al. 1995
• Strategic planning	• Strategic planning
• Priority setting	• Prepare regulation
• Identification of improvements	• Identifying hot-spots
• Product or process design/redesign	• Comparing options within one life cycle
• Selection of performance indicators	• Identify research priorities
• Marketing (declaration, claims, ecolabelling)	• Compare products
	• Education
	• Information
	• Ecolabelling

Table 2: A typology of application areas (from WEIDEMA, 1993; slightly modified)

	Enterprise specific	Generic
Operational:		
Information	• Product declaration	• Consumer information
Change	• Product development (initial phases: hot spot identification)	• Product oriented research (non-comparative)
Tactical:		
Information	• Marketing claims	• Environmental labelling criteria
Change	• Supplier and/or employee requirements and incentives	• Product standards, taxes, and subsidies
Strategic:		
Information	• Enterprise specific performance	• Generic performance criteria
Change	• Product development (design choices, hot spot elimination)	• Product legislation (e.g. societal action plans)

Other suggestions for a typology have used the same distinctions, although with slightly different labels:

FLEISCHER (1992) suggests a 2:2 typology based on time horizon (existing or new products) and selection basis (one product or several products). The latter parameter is a parallel to the distinction between "enterprise specific" and "generic" in WEIDEMA (1993).

WENZEL et al. (1994, 1997) distinguishes between "focus" and "choice", parallel to the "information" versus "change" distinction of WEIDEMA (1993), and furthermore points out that different applications may require very different time horizons, degrees of spatial detail and amount of weighting (the final step in impact assessment).

Based on BAUMANN (1995), FÖRSTER (1996) distinguishes the parameters:

- Decision type: whether the study aims at information or supporting a choice.
- Decision situation: "construction and design", "purchase and sales" and "strategic decisions" (parallel to the "operational", "tactical" and "strategic" levels of WEIDEMA (1993)).
- Decision validity: time and space, interest groups affected.

She further defines three types of actors/decision makers:

a) One which decides on the instrument only, but not the result (e.g. an ecolabelling body, which sets the framework but does not take the final (purchase) decision),

b) One which decides on the result only, but not the instrument (e.g. the consumer, which takes the purchase decision, but do not decide on the life cycle assessment method),

c) One which decides on both instrument and result (e.g. an enterprise using life cycle assessments for product development).

The suggestion that one of the essential parameters for differences in methodology may be the *time horizon*, is taken up by FRISCHKNECHT (1997), based on discussions in a SETAC working group (CLIFT et al. 1997). Four application areas depending on time horizon are distinguished:

- Historical (not relating to any choice), e.g. for environmental reporting, environmental declaration and hot spot identification, although the latter application eventually aims at choices/changes and therefore may as well be performed with the same methodology as one of the below:
- Short term system optimisation (choices within existing capacity of existing technology), e.g. "one extra passenger"-situations,
- Mid-term decisions (choices taking into account changes in capacity within existing technology (mix)), typically the situation in industries with little or no technology development,
- Long-term decisions (choices taking into account both change in capacity and in technology (mix)).

As the length of technological cycles vary much between different product areas, the actual position in time of these four areas depends on the specific products studied.

This distinction may be related to the typology in **Table 2**, in that the operational applications may be regarded as belonging to the type "historical", while the strategic applications typically involve mid- or long-term decisions.

WENZEL (1998) distinguishes three basic levels of life cycle assessments:

- matrix or qualitative life cycle assessments, applicable when trade-offs between different impact categories are simple or non-existent,
- screening life cycle assessments, applicable when trade-offs need to be quantified and this can be done on the basis of available data,
- full life cycle assessments involving data collection, necessary when available data are not adequate to give clear answers.

He further suggests that the choice between these three basic levels is related to the first of three parameters influencing the methodology used for life cycle studies, namely:

- the environmental consequence of the decision, also influencing the choice of time and space,
- the socio-economic consequence of the decision, influencing the need for transparency and documentation, and
- the decision context, which influences the choice of impact categories and the impact assessment method.

2 Discussion

Figure 1 is an attempt to place the aforementioned parameters in relation to each other. The vertical axis represents *time*, while the horizontal axis may be interpreted as both *geographical space* and as the more abstract "*area of affected products and interest groups*".

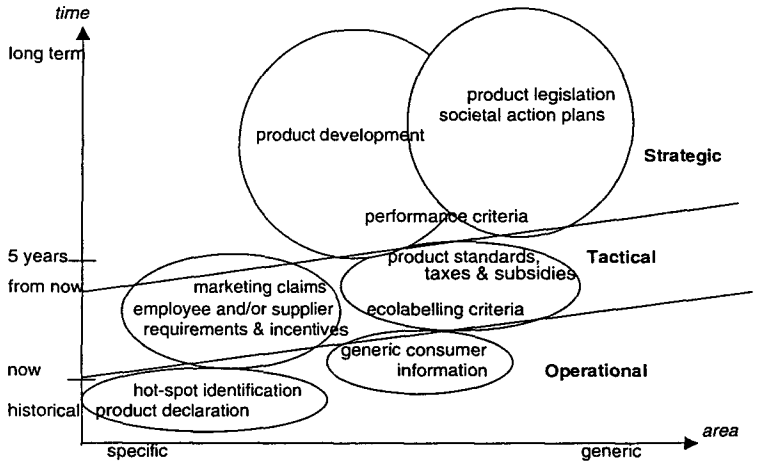

Figure 1: The application typology of table 2 in relation to its determining parameters

The 12 application areas from Table 2 fit nicely into this diagram. However, the decision type (i.e. the information/focus versus choice/change) distinction does not seem to affect the position of the respective applications in relation to time and area. It may also be argued that the distinction is artificial since the purpose of any information ultimately is to affect a choice, even for such a seemingly "neutral" application as "product declarations".

From another point of view, the decision type (as defined above) may be seen as reflecting the degree of pro-activeness of the decision maker, where the applications labelled "change" in Table 2 are more actively influencing the product and the environment than the more passive applications labelled "information". This, however, does not affect the scope of the study (as represented here by time and area).

As pointed out by WENZEL (1998), the decision-maker may further influence the inventory analysis (in that different decision-makers have different amounts of time and money and thus can afford different levels of data collection and sophistication), and the impact assessment (in that different decision-makers may have different interests in including impact categories and different values to be applied in the final weighting), but these aspects are also independent of the application areas represented in Table 1 and 2 (although it may be argued that moving from right to left in Figure 1, the decision maker cannot ignore an increased demand for the impact assessment methodology to be generally accepted). Thus, the decision-maker parameter may be seen as an independent third dimension to Figure 1.

In general, although the 6 application areas (→ *Fig. 1*) may be regarded as discrete (since they can be given discriminating definitions), the method may be affected in a continuous manner when moving the application along the axes of Figure 1.

3 Conclusion

Based on the above review and discussion, the influence of the application area on the methodology of life cycle assessments may be summarised as follows:

- the *scope* of the study is determined by the required decision validity (FÖRSTER 1996), i.e. the systems studied must adequately address the affected products, processes and interest groups in time and space, as reflected in Figure 1 distinguishing 6 overall application areas, which differ in this respect,
- the depth of the study, i.e. the degree of detail in the *inventory analysis*, is determined – independently of the application area – by the complexity of the trade-offs between the involved environmental impacts and by the resources (time and money) available (WENZEL 1998),
- the *impact assessment* methodology is determined by the decision maker (type a or c, according to the terminology of FÖRSTER 1996), independently of the application area, although general acceptance of the chosen method is more important the more generic the application,

- the *reporting* format is determined by the socio-economic importance of the decision (WENZEL 1998), the background and education of the intended audience and the time available for decision making. Some difference in these respects may be found between the 6 application areas in **Figure 1**.

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Received: March 5th, 1998
Accepted: June 24th, 1998

Impressum

The International Journal of Life Cycle Assessment, Vol. 3, No. 4, 1998
http://www.ecomed.de/journals.htm

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LCA 1998: 6 issues, 64 pages each
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Combined rate with one of our other environmental journals:
1998: U.S. $ 195.50 / DM 348,- plus postage

Webmaster: Rainer H. Schwandt, ecomed publishers

Cover Design: Werner Beck, Grafik Design, D-86807 Buchloe, Germany
Edwin Grondinger, abc Fotosatz GmbH, D-86807 Buchloe, Germany

Typesetting, Graphics and Quality Control:
ML Services, Kirschenweg 7, D-86916 Kaufering, Germany

Print Production: VeBu Druck GmbH, Am Reutele 18,
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Internet: http://www.ecomed.de

ISSN: 0948-3349
Abbreviation: Int. J. LCA